IN THE SPECIFICATION:

Please amend paragraph number **[0001]** as follows:

[0001] This application is a continuation of application Serial No. 09/809,720, filed March 15, 2001, now U.S. Patent ~~6,599,660,~~ 6,599,666, issued July 29, 2003.

Please amend paragraph number **[0002]** as follows:

[0002] Field of the Invention: The present invention relates to photolithography techniques used in semiconductor device manufacturing processes. Specifically, the present invention relates to a multi-layer, attenuated phase-shifting mask or reticle that reduces problems associated with side lobe printing in areas including ~~closely-spaced~~ closely spaced or nested features, while maximizing resolution and depth-of-focus performance for isolated features of a semiconductor device.

Please amend paragraph number **[0003]** as follows:

[0003] State of the Art: Photolithography processes are essential to the fabrication of state of the art semiconductor ~~die.~~ dice. Such processes are used to define various semiconductor die features included in semiconductor dice and generally include exposing regions of a resist layer to patterned radiation corresponding to the semiconductor die circuit feature to be defined in a substrate underlying the layer of resist. After exposure, the resist layer is developed to selectively reveal areas of the substrate that will be etched to define the various device features while selectively protecting those areas of the substrate which are not to be exposed to the etching process. In order to properly form a radiation pattern over a resist layer, the radiation is generally passed through a reticle or mask which projects the semiconductor die feature pattern to be formed in the resist layer.

Please amend paragraph number **[0005]** as follows:

[0005] As the pattern features of a binary mask are defined by boundaries between opaque, radiation blocking material and material which is completely radiation transmissive,

radiation passing through a binary mask at the edge of a pattern feature will be diffracted beyond the intended image boundary and into the intended dark regions. Such diffracted radiation prevents formation of a precise image at the feature edge, resulting in semiconductor die features which deviate in shape or size from the intended design. Because the intensity of the diffracted radiation drops off quickly over a fraction of a micron, diffraction effects are not particularly problematic where semiconductor ~~die~~ dice have dimensions on the order of 1 μm. However, as feature dimensions of state of the art semiconductor ~~die~~ dice shrink well below 0.5 μm, the diffraction effects of binary masks become terribly problematic.

Please amend paragraph number **[0006]** as follows:

[0006] Another type of mask known in the art is an attenuated phase shift mask (APSM). ~~APSM's~~ APSMs were developed to address the diffraction problems produced by binary masks and are distinguished from binary masks in that, instead of completely blocking the passage of radiation, the less transmissive regions of the mask are actually partially transmissive. Importantly, the attenuated radiation passing through the partially transmissive regions of an APSM generally lacks the energy to substantially affect a resist layer exposed by the mask. Moreover, the partially transmissive regions of ~~ASPMs~~ APSMs are designed to shift the passing radiation 180° relative to the radiation passing through the completely transmissive regions and, as a consequence, the radiation passing through the partially transmissive regions destructively interferes with radiation diffracting out from the edges of the completely transmissive regions. Thus, the phase shift greatly reduces the detrimental effects of diffraction at the feature edges, thereby increasing the resolution with which sub-micron features may be patterned on a resist layer.

Please amend paragraph number **[0009]** as follows:

[0009] The electromagnetic intensity represented by the second curve components 26a, 26b is also known as "ringing ~~effects," and~~ effects," and one significant disadvantage of APSMs is that such ringing effects become much more severe as feature density

of an APSM increases. As device features designed into an APSM are spaced closer and closer together, the ringing effects of adjacent device features begin to overlap, and as the ringing effects overlap, the electromagnetic intensity of such ringing effects becomes additive. These increased ringing effects are known as "additive side lobes," "additive ringing effects," or "proximity effects." In contrast to isolated ringing effects produced by isolated device features, the electromagnetic intensity of additive side lobes created by ~~closely-spaced~~ closely spaced (i.e., ≤ 0.5 μm) or nested device features often becomes sufficiently intense to cause printing of the resist layer, which is commonly termed "side lobe printing."

Please amend paragraph number **[0010]** as follows:

[0010] Illustrated in drawing FIG. 2 is the additive ringing effects associated with conventional APSMs having ~~closely-spaced~~ closely spaced feature formations. As illustrated in drawing FIG. 2, a second APSM 30 includes a transparent substrate 32 coated with a partially transmissive ~~phase shifting~~ phase-shifting film 34 (again, for ease of description, drawing FIG. 2 provides a greatly simplified APSM). The partially transmissive phase-shifting film 34 has been patterned to form four attenuating regions 36a-36d and three completely transmissive regions 38a-38c, which are ~~closely-spaced.~~ closely spaced. Radiation 39 incident on the APSM 30 passes through the completely transmissive regions 38a-38c and the attenuated regions 36a-36d and impinges upon the surface of the resist layer to be patterned (not illustrated in drawing FIG. 2).

Please amend paragraph number **[0011]** as follows:

[0011] Included in drawing FIG. 2 is a graph 40 illustrating the electromagnetic intensity of the radiation incident upon the surface of the resist layer to be patterned. The graph 40 includes an intensity curve 42 made up of various components, with the first components 43a-43c illustrating the electromagnetic intensity of the radiation passing through the completely transmissive regions 38a-38c of the APSM 30, the second components 44a, 44b illustrating the electromagnetic intensity of the ringing effects produced by the radiation passing

through the isolated attenuated regions 36a, 36d, and the third components 46a, 46b illustrating the electromagnetic intensity of the additive side lobes produced by the dense feature arrangement formed by the ~~closely-spaced~~ closely spaced attenuated regions 36b, 36c. As can be seen in drawing FIG. 2, the magnitude of the second components 44a, 44b (represented by line "I_1"), which illustrate the intensity of the ringing effects produced by isolated attenuated regions 36a, 36d, is significantly lower than that of the third components 46a, 46b (represented by line "I_2"), which illustrate the electromagnetic intensity of the additive side lobes.

Please amend paragraph number **[0015]** as follows:

[0015] Furthermore, state of the art semiconductor ~~die~~ dice often include ~~closely-spaced~~ closely spaced or nested features as well as features which are isolated. It would, therefore, be an improvement in the art to provide an APSM that includes highly attenuated regions (i.e., attenuating regions allowing about 4% to about 10% transmittance of incident radiation) where necessary to control additive ringing but also includes slightly attenuated regions (i.e., attenuating regions allowing about 12% to about 20% transmittance of incident radiation) where isolated device features are to be formed. Such an APSM would enable control of additive ringing effects where needed without compromising resolution and depth-of-focus performance where additive ringing effects are of little or no concern.

Please amend paragraph number **[0016]** as follows:

[0016] The present invention addresses the foregoing needs by providing an APSM that, in each embodiment, includes completely transmissive regions sized and shaped to define desired device features, slightly attenuated regions at the edges of completely transmissive regions corresponding to isolated device features, highly attenuated regions at the edges of completely transmissive regions corresponding to ~~closely-spaced~~ closely spaced or nested device features, and completely opaque areas where it is desirable to block transmission of all radiation through the APSM. The present invention further provides methods for fabricating the APSMs according to the present invention.

Please amend paragraph number **[0021]** as follows:

[0021] A third resist is deposited over the second intermediate mask structure. The third resist is then patterned to form a third patterned resist, which exposes areas of the second intermediate mask structure wherein highly attenuated regions will be formed. The areas exposed by the third patterned resist are then etched to remove only the opaque layer, thereby defining regions were incident radiation is phase shifted one hundred eighty degrees (180°) and highly attenuated as it passes through both the first and second attenuating layers. Preferably, such highly attenuated regions are formed at the edges of completely transmissive regions corresponding to ~~closely-spaced~~ closely spaced or nested device features, thereby increasing the resolution of such semiconductor die features projected by the finished mask, while minimizing or eliminating any defects from additive ringing effects.

Please amend paragraph number **[0050]** as follows:

[0050] Highly attenuated regions 86a-86e are then formed by selectively etching the opaque layer 66 in the exposed area 85 (see drawing FIG. 10). The opaque layer 66 can be etched using any suitable etch process, such as the processes already discussed herein. After formation of the highly attenuated regions, the third patterned resist 84 is stripped, leaving a complete APSM 88 according to the first embodiment of the APSM of the present invention (shown in drawing FIG. 11). It is easily appreciated from reference to drawing FIG. 11 that the highly attenuated regions 86a-86e are preferably formed at the edges of ~~closely-spaced~~ closely spaced transmissive regions 74b-74e which are ~~closely-spaced.~~ closely spaced. Because of the one hundred eighty degree (180°) phase shift provided by the first attenuating layer 62 and the high total attenuation provided by the highly attenuated regions 86a-86e, the highly attenuated regions 86a-86e formed at the edges of ~~closely-spaced~~ closely spaced completely transmissive regions 74b-74e greatly increase the resolution with which the isolated completely transmissive regions 74a, 74f define desired device features, while minimizing or eliminating any fabrication defects that may otherwise occur due to additive ringing effects.

Please amend paragraph number **[0051]** as follows:

[0051] As can be appreciated by reference to drawing FIG. 11, even after formation of completely transmissive regions 74a-74f, slightly attenuated regions 80a-80d, and highly attenuated regions 86a-86e, portions of the opaque layer 66 remain, forming opaque regions ~~90a-90d.~~ 90a-90d. Opaque regions 90a-90d may be maintained on the finished APSM to prevent exposure to even attenuated radiation where attenuated radiation is not needed to increase image resolution. The first embodiment of the method of the present invention, therefore, provides an APSM having completely transmissive regions, highly attenuated regions, slightly attenuated regions, and opaque regions, which work in concert to maximize image resolution and depth-of-focus for isolated features, while minimizing or eliminating any defects caused by additive ringing effects in areas of high feature density and preventing any defects caused by transmission of attenuated radiation where attenuated radiation is not needed to enhance resolution and depth-of-focus.

Please amend paragraph number **[0058]** as follows:

[0058] As can be appreciated by reference to drawing FIG. 16, which illustrates a third intermediate mask structure 120, the slightly attenuated regions 122a-122d are then created by etching the opaque layer 106 and the second attenuating layer 104 in a single step using a Cl_2/O_2 plasma etch process, which stops at the exposed portions 124a-124d of the etch stop layer 102, thereby reducing the number of etch steps necessary to form the slightly attenuated regions ~~122a-122d~~ 122a-122d relative to the first embodiment of the method of the present invention.

Please amend paragraph number **[0062]** as follows:

[0062] As was true in the first embodiment of the APSM of the present invention, the highly attenuated regions 132a-132e included in the second embodiment of the APSM 134 of the present invention are preferably formed at the edges of the ~~closely-spaced~~ closely spaced completely transmissive regions 114b-114e. The one hundred eighty degree (180°) phase shift

provided by the first attenuating layer 100 and/or the etch stop layer 102 and the high total attenuation provided by the combined attenuations of the first attenuating layer 100 and the second attenuating layer 104, enhance the resolution of the images projected by the ~~closely-spaced~~ closely spaced completely transmissive regions 114b-114e, while minimizing or eliminating any fabrication defects that may otherwise occur due to additive side lobes produced by the ~~closely-spaced~~ closely spaced completely transmissive regions 114b-114e.

Please amend paragraph number **[0064]** as follows:

[0064] Though the method and APSM of the present invention have been described and illustrated herein with reference to two different embodiments, such descriptions and illustrations do not limit the scope of the present invention. The method of the present invention and design of an APSM according to the present invention are highly adaptable. For example, the method disclosed herein can be used to fabricate APSMs having any desired feature pattern. Moreover, the steps of the method and composition of the APSMs can be modified in several aspects while still obtaining an APSM according to the present invention. For instance, the method of the present invention may utilize etching processes different from those discussed herein. Additionally, materials different than those described herein, such as, different substrate materials, different attenuating materials, different light blocking materials, or different etch stop materials, may be used in conjunction with the method of the present invention to fabricate ~~APSM~~ APSMs according to the present invention having a different material composition than the APSMs according to the first and second embodiments. Therefore, the present invention is not to be defined or limited by the illustrative and descriptive examples provided herein, but, instead, the scope of the present invention is defined by the appended claims.